Computerizing Goldstone Facility Maintenance Data for Management Decisions

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This article is the result of a study done with a view to computerizing the facility maintenance management operations at the Goldstone Deep Space Communications Complex (GDSCC). It briefly describes the Data Management system in existence at the time the study was initiated and a proposed Automated system. Further, it gives results of development work to date, provides a few sample results and identifies other areas of work, some of which are currently in progress or in the planning stage.

I. Background

Several attempts were made in the past to improve the operational efficiency of the Goldstone Facility Maintenance (GFM) Work Control Center (WCC). Visits to other facilities and plant operations in the Southern California area were made. Management audits were conducted to identify information flow, functions performed, and various tasks required to coordinate and schedule the preventive maintenance, corrective maintenance and special work activities performed under direction of the GFM plant engineer.

II. Justification of Recent Management Audits

The Deep Space Network (DSN) Facility Operations Manager is responsible for providing day-to-day support to facility installations and for providing special support to spacecraft missions and research and development (R&D) activities throughout the DSN. During the past few years DSN Management has been compelled to provide this support with reduced resources. Current indications are that this mode of operation will continue.

In addition to the above trend, one of JPL's long-range goals is to implement a Centralized Management Data Base system. The GFM support unit will be a user of this Data Base system and has recently provided to the Data Base designers estimates of GFM data requirements.

A further justification is to permit analytical assessment of manpower planning and budget estimating as demands for services vary in Cost Centers over a given planning horizon time. Such analyses will permit Cost Center managers to utilize modern management science techniques in arriving at efficient decisions.

III. Existing GFM Data System

The current data system is a manual data acquisition, information handling, and processing system. The GFM data system consists of a preventive and corrective maintenance operation, a Maintenance Work Order system and a Work Request system.

The Preventive Maintenance (PM) file, which consists of approximately 1,500 line items, is maintained in a Cardex file system located in the WCC. Figure 1 depicts the Cardex file system, and Figure 2 is a sample card upon which is recorded both the static history information about a unique PM item and the transaction information which includes Maintenance Man-Hours (MMH), material costs and any special comments noted by the technician. In addition to the PM work, the WCC maintains a Maintenance Work Order (MWO) and a Work Request (WR) data system for approximately nine shops. This information is manually recorded on individual shop ledgers, 3 × 5 card files, personal ledger files in addition to the shop ledger files, a suspense file and a centralized secretarial file system. The MWO system encompasses corrective maintenance for those items which have PM numbers, and other minor maintenance jobs. The WR system is designed to handle major and expensive maintenance jobs or those jobs resulting in subcontracts. Figure 3 depicts a MWO form and Figure 4 is a WR form.

The current Data Base System is encumbered with a superfluous amount of paper work, a multiplicity of data recording which results in time delays for report generation, excessive man-hours spent in data recording, a higher potential for data errors, and inefficient data management, to name a few areas for improvement.

Once the assigned jobs are accomplished by the shop personnel, the shop leadman prepares a summary of activities performed by his shop and submits a report to the WCC on a Work Report form (Figure 5).

The data recorded on the forms, as shown in Figures 2–5, are manually transcribed to the various shop ledgers, card files and personal files prior to preparing any shop, material or management report required for decision making.

IV. A Proposed Computerized System for the GFM Data Base

The overview of the GFM computerized Data Base System is shown in Figure 6. It basically indicates that all work scheduling, computations, and report generation will be performed by the computer with data input, work planning and job estimating done by the WCC personnel. One Data Base will be maintained rather than a multiplicity of data files. Key job statistics and transaction information will be entered into the computer by WCC personnel via a remote computer terminal (see Figure 7). All processing and report generation will be automated to provide near-real-time management reports.

The GFM Data Base which is currently being designed for computer implementation will serve two major users. One of the users will be JPL management personnel and the other group includes Goldstone Facility supervision, WCC planners and shop leadmen.

The type of data provided and information processing requirements of the two groups are somewhat diverse. Management on the one hand requires information about current operations and expenses; on the other hand, it requires information pertinent to workload and manpower planning for both short-term and long-term projects. The WCC planners and shop management personnel are more concerned with the daily, weekly, and monthly job scheduling, outstanding purchase requests, backlog of jobs and availability of craftsmen for workload planning.

Typical management reports required are as follows:

(1) Shop Work Schedules.

(2) Weekly Workload Summaries.

(3) Shop Backlog.

(4) Subcontractor Status Report.

(5) Material Budget Account.

(6) Monthly/Quarterly Expenditure Reports.

(7) Shop Workload Experience Report.

(8) Equipment History Report.

(9) Workload and Manpower Planning.

Computer input requirements necessary to facilitate the above reports are exhibited in Figures 8–12. The essential statistics of each maintenance activity, i.e., job number, man-hours and material costs, are input to unique computer files via the appropriate file format, for example, on a weekly basis. Once these basic data are stored in the computer, WCC or management reports can be generated by utilizing the special-purpose application programs to summarize, by shop, over a given time period, the man-hours and material costs expended, number of jobs completed, number of jobs in the shop backlog, etc.

As the GFM Data Base expands, statistical analysis can be performed on certain data in order to:

(1) Detect the expected number of emergency calls per shop.

(2) Detect abnormalities in types and frequency of repairs.

(3) Provide essential statistics to permit cost trade-offs on repair or buy decisions.

(4) Estimate trends in demands for services per shop.

(5) Estimate workload and manpower requirements.

(6) Determine energy consumption and other types of analyses normally not apparent in a manual Data Base System.

These types of features are desirable for DSN Facility Operations and substantial cost savings could be realized by improvements in the GFM operational efficiency.

Additional potential areas for improvement in facility operations are scheduling, manpower utilization, organization of data files, timeliness of management reports, accuracy of the data base, and planning and availability of more useful and pertinent information on overall facility operations.

V. Status of the GFM Data Base

To minimize transition problems during the conversion to a Computerized Management Data Base System, implementation is taking place in phases.

The GFM automated system entails providing the computer with major blocks of information which contain a comprehensive set of data about Goldstone buildings, equipment, meters, type of maintenance activities, personnel, budgetary information, and the necessary application software required to process the Facility Data into meaningful Management Reports.

An input file generator program is required to input data to computer-generated files; housekeeping routines are necessary for file updating and querying the GFM data base files; and special-purpose application programs are necessary for generating management reports and analyses.

The File Generator Program is currently the GFM data base workhorse as it permits the user to create preventive maintenance files, maintenance work order files, work request files, an index file, utility meter static history files and meter transaction data files. History files maintain static information, whereas the transaction data files maintain data which change as a function of time.

Editor, edit-aid and sort programs assist the user in performing limited housekeeping, updating, and modifications of existing GFM files.

Application programs generated to date include a Utility Report program, an Energy Consumption Report and a Plot Routine. The Utility Report program provides monthly, last 3 months, last 6 months, last 12 months and year-to-date reports of electrical, liquified petroleum gas (LPG) and water usage. A plot option exists in the Utility Report program when the user requests a 6-month, 12-month or year-to-date report. As of 1 March 1976 the diesel fuel (DF) meters will be installed, software changes as required will be updated and the Utility Report will then include diesel fuel usage.

Recent interest by NASA resulted in a GFM Energy Consumption program being generated. This program allows the user to select an interval of time for which data are to be extracted from existing data files and then summarizes all utility consumption of electrical, LPG and DF in thermal units for a consolidated Energy Consumption Report.

VI. Results of Development Work

Figure 13 is a monthly Utility Usage Report for December 1975. It identifies the power, water, LPG and diesel fuel meter location, meter number, monthly usage of the appropriate parameter being monitored and the percent change from the previous month for each meter.

Figure 14 is a 6-month report of total usage for each meter. It represents the period of July 1975 through December 1975 and identifies the meter location, meter

code, percent change during the two quarters, and total semi-annual consumption. During the generation of this latter report, but prior to printout, the user is questioned by the computer as to whether a plot of monthly usage is required. If the user responds by typing "yes," the computer automatically stores the monthly results for each meter in a temporary file. After printing the report as denoted in Figure 14, the computer informs the user that the data for plotting are stored in a temporary file and the user is instructed to load the plot routine for plotting the meter data.

The plot routine queries the user, meter by meter, by asking if the respective meter data are to be plotted. Figure 15 is a plot of the monthly electrical usage for the meter titled "Main Sub SCE" over the 6-month period noted above.

The annual (last 12 months) and year-to-date reports are similar in format, i.e., a two part report is generated. The first part of the report summarizes by meter the consumption during both the first half and second half of the year, and the total annual consumption for each parameter monitored. The second part of the report generates for the respective meters the quarterly consumption for the respective parameters. Should the user at the appropriate time inform the computer that monthly data should be saved for plotting, the computer, after printing the Annual Report, informs the user to load the Plot Routine to obtain plots of the appropriate meter's monthly trends. Figures 16 and 17 are respectively Part I and Part II of the Annual Utility Usage Report.

The DSN tracking facilities in general consume a considerable amount of energy, and since the recent energy crisis, it has become mandatory that JPL provide NASA with a report of Goldstone monthly energy consumption for the previous quarter.

Figure 18 is a copy of the Energy Consumption Report generated by the GFM Energy Consumption Program. Part I represents the monthly consumption in LPG, DF, and electrical power with the total monthly consumption converted to megawatt hours thermal units (MWHT). Column totals are presented for LPG, DF, electrical power and total MWHT. A second total in thousands (kilo) of dollars is displayed for the cost of electrical power. No costs are included for LPG or DF.

As a result of the above work, the following improvements in the Work Control Center's efficiency have been achieved:

(1) The Monthly Utility Usage Report, which consisted of approximately 15 pages, has been reduced to a maximum of 2 pages and a cover letter.

(2) Report preparation time, which took from 2 to 4 weeks, has been significantly reduced to basically computer access time.

(3) A reliable Energy Consumption Data Base has been established.

(4) Computation errors are basically non-existent and the accuracy of the reports is dependent on the accuracy of the data input to data files.

(5) Expanded capability exists in energy reporting not previously available in the manual recording system.

VII. Planned Activities

There are a number of tasks either in the development or planning stage which are to be completed this fiscal year. The major tasks are identified as follows:

(1) Create Preventive Maintenance Static History and Transaction Data Files, Maintenance Work Order Files and Work Request Files for calendar years 75 through 76.

(2) Extend the capability of the File Generator Program to allow WCC users to create building, budget, procurement and personnel files.

(3) Develop and implement a scheduling algorithm that will establish optimum weekly and monthly shop schedules for Preventive Maintenance, Maintenance Work Orders and Work Requests.

(4) Develop and implement an updating algorithm for the Maintenance Work Order and Work Request Files.

(5) Investigate the application of Relational Data Base capabilities to the GFM Data Base System.

(6) Extend development work of the preliminary workload and manpower planning model to accommodate time-varying demand statistics and manpower constraint in order to estimate budgetary requirements for management decisions.

(7) Develop procedures and algorithms for estimating parameters utilized in the workload and manpower planning model.

(8) Develop and implement a preliminary budget planning model.

(9) Develop and implement the GFM Expenditure Report.

(10) Provide consulting support to GFM personnel with respect to the above procedures.

VIII. Conclusion

The GFM on-line computerized management system is an important technique for increasing the Goldstone Facility Maintenance Work Control Center efficiency and will play a vital role in the plant engineering and facilities management at Goldstone. In the near future, we expect optimal scheduling, improved facilities management by exception and objective planning, better manpower utilization, workload analysis and budget planning.

At this point in time of reducing DSN resources, rising labor and material costs, the DSN manager and GDSCC facilities supervision must use every management science tool available. By taking advantage of advances in computer technology and utilizing special-purpose GFM application programs as previously noted, the GDSCC Facility Support Unit will improve its operational efficiency.

Fig. 1. Cardex file of PM data

ELECTRICAL DEPARTMENT SWITCH GEAR MAINTENANCE RECORD

LOCATION	MOTOR STARTER	FUSE SIZE
I D NO.	NEMA SIZE	CONTROL TRANS.
L A NO.	COIL CAT. NO.	KVA VOLTAGE
MANUFACTURE	COIL VOLTAGE	MAKE
CAT. NO.	LINE VOLTAGE	
SERIAL NO.	BREAKER SIZE	TRANSITION
STYLE	BREAKER TYPE	HEATER SIZE
MODEL	TRIP DEVICE	
TYPE		
NEMA CL.		
DESIGN		
DATE INSTALLED		
DRAWING NO.		

JPL 5118-s/DSIF(8/69)

ITEM: COST MAINTENANCE RECORD

DATE	LABOR	MAINT	DATE	LABOR	MAINT	DATE	LABOR	MAINT
PM #			GOVT #			BLDG #		

Fig. 2. Cardex file card

MAINTENANCE WORK ORDER

EQUIPMENT #	LA #	DATE	TIME RECEIVED
EQUIPMENT NAME		HP	REPORTED BY
DEPARTMENT	SECTION #		ASSIGNED BY
BUILDING	ROOM	DATE	TIME
OTHER LOCATION			ASSIGNED TO
SCHEDULED WORK M Q SA A	UNSCHEDULED WORK		JOB #
ORIGINATOR			APPROVED BY

WORK PERFORMED

TOTAL TIME REQUIRED _____

JPL 1013 DEC 62

Fig. 3. Maintenance work order form

GOLDSTONE DEEP SPACE COMMUNICATION COMPLEX

WORK REQUEST

ACCOUNT NO. TO BE CHARGED	INSTRUCTIONS
	ORIGINATOR COMPLETE ALL INFORMATION NOT ENCLOSED WITHIN HEAVY LINES AND FORWARD WORK REQUEST TO MAINTENANCE OFFICE.

DATE _____

ORIGINATOR		STATION	BLDG.	EXT.

REASON FOR REQUEST (JUSTIFICATION)	REQUISITION NO.	PURCHASE ORDER

SERVICE	ESTIMATE		ACTUAL COST	
	MATERIAL	LABOR	MATERIAL	LABOR
AIR COND.				
CARPENTER				
CONCRETE				
CONTRACT				
DRAFTING				
ELECTRIC				
ENGINEER				
GRADING				
MATERIAL				
PAINTING				
PHOTO				
PLUMBING				
SHEET MT.				
WELDING				
TOTAL				

DESCRIPTION OF REQUEST (INCLUDE SKETCHES, DWGS., ETC.)

ENGINEER APPROVAL	DATE
MAINTENANCE APPROVAL	DATE
AUTHORIZATION TO PROCEED	DATE

DATE REQUIRED | PREPARED BY

SUPERVISOR SIGNATURE

ACKNOWLEDGEMENT

TO	DATE

ANTICIPATED COMPLETION DATE | ESTIMATED COST

REMARKS

MAINTENANCE OFFICE

Fig. 4. Work request form

WORK REPORT

DATE _____

NAME _____ SHIFT _____ CRAFT _____

WORK DESCRIPTION	START TIME	STOP TIME	HOURS
F-030	**TOTAL**		

Fig. 5. Work report form
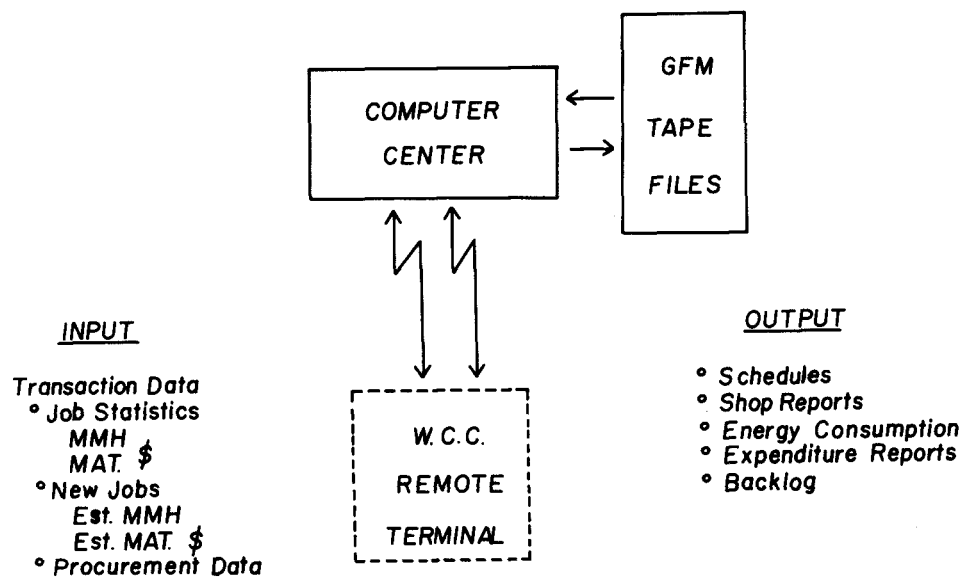
Fig. 6. Overview of GFM data base system

INPUT

Transaction Data
  ° Job Statistics
      MMH
      MAT. $
  ° New Jobs
      Est. MMH
      Est. MAT. $
  ° Procurement Data

OUTPUT

° Schedules
° Shop Reports
° Energy Consumption
° Expenditure Reports
° Backlog

Fig. 7. Remote computer terminal

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Preventive Maintenance (PM)

    PM History File - Record Layout


          Item                    Field Size      Format

     Shop Code[1]                      1             A
     PM Number                         5             N
     Item Name                        15             A
     Serial Number                    15            A/N
     Government Number                10            A/N
     Model Number                     15            A/N
     Building Number                   3            A/N
     Room Number                       5            A/N
     Date of Purchase                 6]             N
     End*of Warranty Period           6] (MMDDYY)    N
     MMH* - Monthly Std.               4             N
     MMH - Quarterly Std.              4             N
     MMH - Overhaul Std.               4             N
     Special Comments                 55            A/N



*MMH = Maintenance Manhours.

A = Alpha-characters.

A/N = Alphanumeric characters.

[1]See Fig. 12.
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Fig. 8. PM history file record

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    PM Data - Record Layout


        Item                    Field Size      Format

  Shop Code[1]                       1             A

  PM Number                          5             N

  Maintenance Code[1]                2             A

  Status Code[1]                     1             A

  Date of Action (MMDDYY)            6             N

  MMH                                5             N

  Material Cost                      7             N

  Work Description                  50            A/N


[1]See Fig. 12.
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Fig. 9. PM data file record

WORK REQUEST (WR) - RECORD LAYOUT

ITEM	FIELD SIZE	FORMAT
Shop Code[1]	1	A
WR Number	5	N
WR (Maint.) Code[1]	2	A
Originator	15	A
Date Required (MMDDYY)	6	N
Est. Number of Craftsmen	1	N
Est. MMH (XXX.X)	5	N
Est. Material Cost	6	N
Est. Completion Date	6	N
Date Received (MMDDYY)	6	N
Actual Start Date (MMDDYY)	6	N
Actual Completion Date (MMDDYY)	6	N
Actual Number of Craftsmen	1	N
Actual MMH (XXX.X)	5	N
Actual Material Cost	6	N
Status[1]	1	A
Priority[1]	1	N
Building Code	3	A/N
Room Number	5	A/N
Task Description	50	A/N

[1]See Fig. 12.

Fig. 10. Work request (WR) record

MAINTENANCE WORK ORDER (MWO) - RECORD LAYOUT

ITEM	FIELD SIZE	FORM FORMAT
Shop Code[1]	1	A
MWO Number	5	N
MWO (Maint.) Code[1]	2	A
Originator	15	A
Date of Request (MMDDYY)	6	N
Date Required (MMDDYY)	6	N
Est. Number of Craftsmen	1	N
Est. MMH (XXX.X)	5	N
Est. Material Cost	6	N
Status[1]	1	A
Est. Completion Date (MMDDYY)	6	N
Priority[1]	1	N
Actual Number of Craftsmen	1	N
Actual MMH (XXX.X)	5	N
Actual Material Cost	6	N
Building Code	3	A/N
Room Number	5	A/N
Task Description	50	A/N

[1]See Fig. 12.

Fig. 11. Maintenance work order (MWO) record

CODES FOR COMPUTER INPUTS

1. Shop Codes (Cost Center) ---- one (1) alpha-character.

Code	Shop Description
C	Carpenter & Paint
E	Electrical
M	Machine
G	Engraving
P	Photolab
H	Heavy Equipment (mechanical)
D	Drafting & Engineering
K	Contracts
A	A/C, Heating, Plumbing (Refer Shop)
S	Security

2. Maintenance Codes ----------- two (2) alpha-characters, maximum.

Code	Description
W	Weekly
M	Monthly
Q	Quarterly
SA	Semi-annual
AN	Annual
U	Unscheduled
S	Scheduled
E	Emergency
K	Contractor
P	Philco

3. Status Codes ---------------- one (1) alpha-character.

Code	Description
C	Complete
P	Work in Progress
M	Material Delay
D	Delay Other Than Material
N	Work Not Started
A	Awaiting Approval
X	Cancelled, Not Approved

4. Priority --------------------(To be attached)

Fig. 12. Sample codes for computer input

GOLDSTONE MONTHLY UTILITY USAGE REPORT   DATE:01-27-76

BEGINNING DATE:12-28-75   ENDING DATE:12-28-75
        LOCATION   METER NUMBER   MC   TOTAL KWH KW DEMAND TOTAL KVAR % CHG

                                              X10**3   X10**3   X10**3

LOCATION	METER NUMBER	MC	TOTAL KWH X10**3	KW DEMAND X10**3	TOTAL KVAR X10**3	% CHG
MAIN SUB S.C.E.	180-724	01	795.000	1.830		21.0
MAIN SUB S.C.E.	179-673	02			66.00	0.0
ECHO SITE	60-085-004	03	530.400	.696		248.0
ECHO SITE	60-085-005	04	0.000	0.000		0.0
ECHO SITE	DELETED***	05	0.000	0.000		0.0
FORT IRWIN INTERSECTION	U-301-21477	06	.293	0.000		561.4
PUMP STATION	48-591-353	07	15.500	0.000		252.3
PIONEER SUB	43-897-195	08	241.200	.384		48.9
PIONEER SITE	46-493-495	09	0.000	0.000		0.0
PIONEER SITE	46-493-496	10	0.000	0.000		0.0
VENUS SUB #1	24-900-394	11	1585.600	0.000		0.0
VENUS SUB #2	13450	12	66.240	.480		-4.6
VENUS SUB #3	111C275G33	13	32.400	.120		145.5
ANTENNA RANGE	27-298-726	14	4.480	.080		55.6
MARS SITE S.C.E.	F-264-128	15	841.600	1.920		39.9
MARS SITE	RP-14-856	16			304.00	-61.1
MARS SITE	308-73320	17	0.000	0.000		0.0
GOLDSTONE TOTAL USAGE				1636.60	3.75	

WATER, LPG & DIESEL USAGE REPORT OF GALLONS DISPENSED X10**3

LOCATION	METER	MC			
GDSCC WATER MAIN	N/A	18	700.700	0.000	-24.9
LPG-ECHO	N/A	19	6.010	0.000	11.3
LPG-PIONEER	N/A	20	1.053	0.000	32.2
LPG-VENUS	LP & 15	21	.673	0.000	-27.6
LPG-VENUS	2	22	.610	0.000	-37.4
LPG-ANT. RANGE	N/A	23	.173	0.000	-35.6
LPG-MARS	N/A	24	.035	0.000	-8.8
ECHO DFG	NONE	25	0.000	0.000	0.0
MARS DFG	NONE	26	0.000	0.000	0.0
PIONEER DFG	NONE	27	0.000	0.000	0.0

Fig. 13. Monthly utility usage report

LOCATION	NO	PERCENT CHANGE THIS QUARTER		SEMI ANNUAL CONSUMPTION X10**3		
		KWH	KVAR	KWH	DEMAND	KVAR
MAIN SUB S.C.E.	01	-10.30		4695.00	13.17	
MAIN SUB S.C.E.	02		-59.63			918.00
ECHO SITE	03	19.65		2092.80	3.01	
ECHO SITE	04	-100.00		95.20	.60	
ECHO SITE	05	-100.00		95.20	.48	
FORT IRWIN INTERSECTION	06	30.95		.87	0.00	
PUMP STATION	07	-2.93		60.50	0.00	
PIONEER SUB	08	-11.44		1285.20	2.30	
PIONEER SITE	09	-100.00		11.52	.23	
PIONEER SITE	10	-100.00		14.08	.33	
VENUS SUB #1	11	19920.00		1609.60	0.00	
VENUS SUB #2	12	808.33		232.32	1.60	
VENUS SUB #3	13	8.16		122.40	.30	
ANTENNA RANGE	14	23.08		16.56	.21	
MARS SITE S.C.E.	15	5.26		4118.40	9.95	
MARS SITE	16		-6.51			3456.00
MARS SITE	17	-100.00		.05	0.00	
GOLDSTONE TOTAL USAGE				8813.40	23.18	

WATER, LPG & DIESEL USAGE REPORT OF GALLONS DISPENSED X10**3

GDSCC WATER MAIN	18	-41.51		9023.70	0.00	
LPG-ECHO	19	142.96		30.71	0.00	
LPG-PIONEER	20	79.08		3.84	0.00	
LPG-VENUS	21	290.97		3.18	0.00	
LPG-VENUS	22	1955.56		2.18	0.00	
LPG-ANT. RANGE	23	325.86		.69	0.00	
LPG-MARS	24	70.00		.14	0.00	
ECHO DFG	25	0.00		0.00	0.00	
MARS DFG	26	0.00		0.00	0.00	
PIONEER DFG	27	0.00		0.00	0.00	

Fig.14. Semi-annual summary of utility consumption

DO YOU WANT PLOTS OF METER 1 DATA? Y=YES,N=NO
?Y

DATA HAS YMIN = 657 YMAX = 852
ENTER YMIN,YMAX FOR PLOT:
650,900

LOCATION:MAIN SUB S.C.E.   MTR NUMBER:180-724   MTR CODE: 1

GDSCC ENERGY CONSUMPTION

MONTHLY ELECTRICAL CONSUMPTION (MEGAWATTS)

```
           6.50      7.00      7.50      8.00      8.50      9.00
           E+02      E+02      E+02      E+02      E+02      E+02
         +----+----+----+----+----+----+----+----+----+----+
M   07-31-75                                              /
O   08-28-75                                          /
N   09-30-75                                      /
T   10-31-75                              /
H   11-26-75        /
S   12-31-75                     \
```
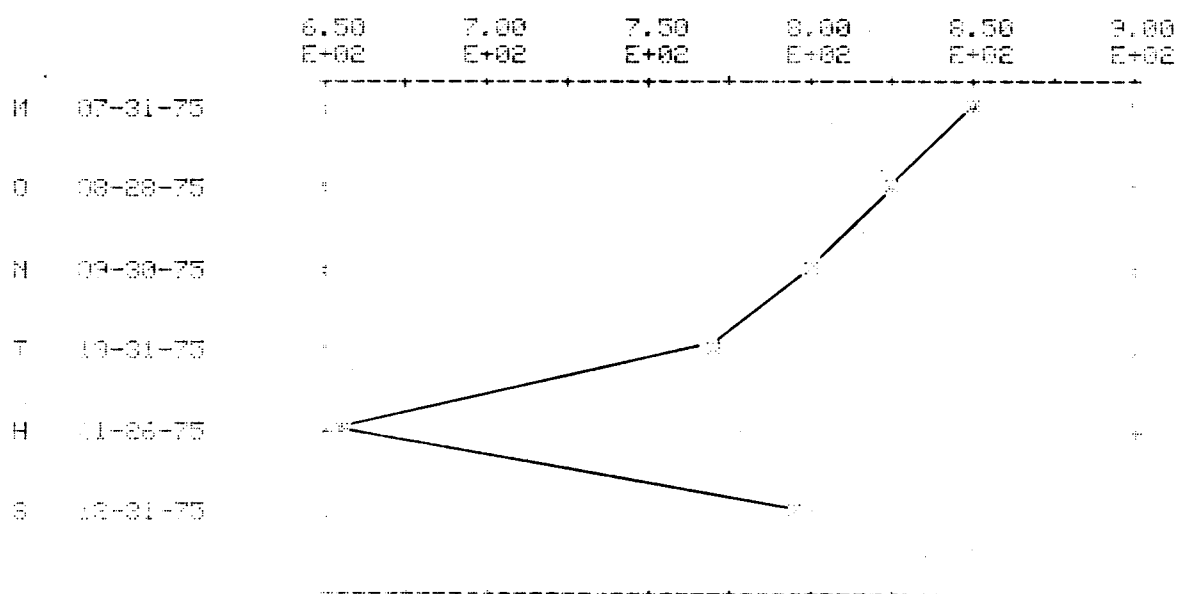
Fig. 15. Computer generated plot of monthly electrical consumption (megawatts)—6-month plot

GDSCC ANNUAL FACILITY USAGE X10**3   DATE:01-28-76

BEGINNING DATE:0175   ENDING DATE:12-28-75
                    PART I: ANNUAL CONSUMPTION SUMMARY

LOCATION	NO	1ST-HALF KWH	DEMAND	2ND-HALF KWH	DEMAND	TOTAL KWH	DEMAND
MAIN SUB S.C.E.	01	4554.00	12.21	4695.00	13.17	9249.00	25.38
MAIN SUB S.C.E.	02	636.0 *		918.0 *		1554.0 *	
ECHO SITE	03	0.00	0.00	2092.80	3.01	2092.80	3.01
ECHO SITE	04	0.00	0.00	95.20	.60	95.20	.60
ECHO SITE	05	0.00	0.00	0.00	0.00	0.00	0.00
FORT IRWIN INTERSECTION	06	.07	0.00	.87	0.00	1.75	0.00
PUMP STATION	07	33.90	0.00	66.50	0.00	99.40	0.00
PIONEER SUB	08	1119.60	1.30	1285.20	2.30	2404.80	3.60
PIONEER SITE	09	51.84	.54	11.52	.25	63.36	.79
PIONEER SITE	10	61.44	.66	14.08	.33	75.52	.99
VENUS SUB #1	11	19.20	0.00	1609.60	0.00	1628.80	0.00
VENUS SUB #2	12	295.68	2.83	232.32	1.60	528.00	4.44
VENUS SUB #3	13	242.40	9.91	122.40	.50	364.80	10.42
ANTENNA RANGE	14	43.20	.23	18.56	.20	61.76	.44
MARS SITE S.C.E.	15	3846.40	8.26	4118.40	9.95	7964.80	18.21
MARS SITE	16	2092.8 *		3456.0 *		5548.8 *	
MARS SITE	17	.08	0.00	0.00	0.00	.08	0.00
GOLDSTONE ANNUAL USAGE						17213.80	63.59

                    *=KVAR MEASUREMENT

WATER, LPG & DIESEL USAGE REPORT OF GALLONS DISPENSED X10**3

GDSCC WATER MAIN	18	6051.30	0.00	9023.70	0.00	15075.00	0.00
LPG-ECHO	19	102.78	0.00	30.71	0.00	133.49	0.00
LPG-PIONEER	20	25.62	0.00	3.84	0.00	29.46	0.00
LPG-VENUS	21	10.85	0.00	3.18	0.00	14.03	0.00
LPG-VENUS	22	8.04	0.00	2.18	0.00	10.22	0.00
LPG-ANT. RANGE	23	3.50	0.00	.68	0.00	4.18	0.00
LPG-MARS	24	.10	0.00	.14	0.00	.23	0.00
ECHO DFG	25	0.00	0.00	0.00	0.00	0.00	0.00
MARS DFG	26	0.00	0.00	0.00	0.00	0.00	0.00
PIONEER DFG	27	0.00	0.00	0.00	0.00	0.00	0.00

Fig. 16. Part I: Annual utility usage report

GDSCC ANNUAL FACILITY USAGE X10**3   DATE:01-28-76

BEGINNING DATE:0175   ENDING DATE:12-28-75
                    PART II: QUARTERLY BACK-UP OF ANNUAL REPORT

MC	KWH (KUAR*) QUARTERLY CONSUMPTION					QUARTERLY DEMAND CONSUMPTION				
	1-QTR	2-QTR	3-QTR	4-QTR	ANNUAL	1-QTR	2-QTR	3-QTR	4-QTR	ANNUAL
01	2154.0	2400.0	2475.0	2220.0	9249.	5.3	6.9	7.2	6.0	25.4
02	228.0	408.0	654.0	264.0	1554 *					
03	0.0	0.0	952.8	1140.0	2093.	0.0	0.0	.8	2.2	3.0
04	0.0	0.0	95.2	0.0	95.	0.0	0.0	.5	.1	.6
05	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0	0.0
06	.4	.5	.4	.5	2.	0.0	0.0	0.0	0.0	0.0
07	15.7	23.2	30.7	29.8	99.	0.0	0.0	0.0	0.0	0.0
08	504.0	615.6	681.6	603.6	2405.	.5	.8	1.2	1.1	3.6
09	31.2	20.6	11.5	0.0	63.	.2	.3	.3	0.0	.8
10	37.1	24.3	14.1	0.0	76.	.3	.3	.3	0.0	1.0
11	4.8	14.4	8.0	1601.6	1629.	0.0	0.0	0.0	0.0	0.0
12	193.9	101.8	23.0	209.3	528.	1.4	1.4	.6	1.0	4.4
13	130.8	111.6	38.8	63.6	365.	7.2	2.7	.3	.3	10.4
14	28.2	15.0	8.3	10.2	62.	.1	.1	.0	.2	.4
15	1744.0	2102.4	2006.4	2112.0	7965.	3.4	4.8	5.0	5.0	18.2
16	950.4	1142.4	1804.8	1651.2	5549 *					
17	.5	.4	0.0	0.0	1.	0.0	0.0	0.0	0.0	0.0

GOLDSTONE ANNUAL USAGE   17613.80   43.59
                    *-KUAR MEASUREMENT

WATER, LPG & DIESEL USAGE REPORT OF GALLONS DISPENSED X10**3

18	2386.8	3964.5	5693.6	3333.1	15375.	0.0	0.0	0.0	0.0	0.0
19	87.6	13.2	9.0	21.8	133.	0.0	0.0	0.0	0.0	0.0
20	22.1	3.6	1.4	2.5	29.	0.0	0.0	0.0	0.0	0.0
21	8.7	2.1	.7	2.5	14.	0.0	0.0	0.0	0.0	0.0
22	6.3	1.7	.1	2.1	10.	0.0	0.0	0.0	0.0	0.0
23	3.0	.6	.1	.6	4.	0.0	0.0	0.0	0.0	0.0
24	.6	.1	.1	.1	.	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0	0.0

                    *-KUAR MEASUREMENT

Fig. 17. Part II: Annual utility usage report

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WHAT IS TODAYS DATE?    MM-DD-YY = 01-18-76
BEGINNING DATE OF INTEREST IS:    MMYY = 0975
ENDING DATE OF INTEREST IS:    MMYY = 0176
DATA FILES REQUESTED ARE MISSING FOR YEAR 1976
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DATE: 01-18-76

ENERGY CONSUMPTION AT GDSCC

BEGINNING DATE:0975   ENDING DATE:0176

PART I: SUMMARY

DATE	LPG K-GAL	MWHT	D.FUEL K-GAL	MWHT	POWER MWH	MWHT	TOTAL MWHT
975	3.625	101	18.390	747	1377.923	4684	5532
1075	9.231	258	.375	15	1525.964	5187	5460
1175	10.197	285	.250	10	1367.958	4650	4945
TOTALS	23.053		19.015		4271.845		15938
TOTAL KILO DOLLARS					116.88		

PART II: SUMMARY

DATE	TOTAL MWHT	CUM MWHT	POWER COST(MO.)	CUM COST(KILO.$)	CUM POWER(MWH)	CUM LPG K-GAL	CUM D.F.K-GAL
975	5532	5532	38162.89	38.16	1377.923	3.625	18.390
1075	5460	10993	40914.97	79.08	2903.887	12.856	18.765
1175	4945	15938	37797.66	116.88	4271.845	23.053	19.015

Fig. 18. Energy consumption at GDSCC